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Hardya helgae nov.sp., a new leafhopper species from Central Europe (Hemiptera: Auchenorrhyncha: Cicadellidae)

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A b s t r a c t : A new species of the leafhopper genus *Hardya* EDWARDS, 1922 from the southwestern parts of Germany, Luxembourg and Eastern France is described. It is similar to the widespread species *Hardya tenuis* (GERMAR, 1821), but differs significantly in the shape of the genital plates, body size and wing length of females. There are also differences in habitat preferences: *Hardya helgae* nov.sp. is confined to more or less dry calcareous grassland and feeds on *Bromus erectus*, whereas *H. tenuis* feeds on Festuca ovina and occurs also in acidic grasslands. There is strong evidence that the new species has, together with its host plant and correlated with changing land use, immigrated into central Europe rapidly only within the last decades.

K e y w o r d s : Cicadomorpha, new species, dry calcareous grassland, immigration, range expansion.

Introduction

The genus *Hardya* was described by the British hemipterist James Edwards and named after his senior colleague James Hardy based on *Aphrodes melanopsis* HARDY, 1850 as type species (EDWARDS 1922). He considered the triangular shape of the genital plates and their widely diverging inner margins as the most important diagnostic character of the genus.

ZAKHVATKIN (1946) described additional species and erected two subgenera, *Eohardya* and *Mimohardya*, both treated as separate genera today. RIBAUT (1952), WAGNER (1955), OSSIANNILSSON (1983), ANUFRIEV & EMELJANOV (1988) and DELLA GIUSTINA (1989) gave concise and detailed descriptions of *Hardya* s.str. and its species. According to these authors, a pair of comb-like dorso-lateral appendages of the pygofer lobes, the apical split of the genital plates and the strongly dilated and transversely truncate styles are also diagnostic characters. The genus is placed into the tribe Athysanini of the subfamily Deltocephalinae (ZAHNISER & DIETRICH 2013).

Currently, ten species of *Hardya* EDWARDS, 1922 (s.str.) are known. They are all living in open habitats and feeding on Poaceae. Three groups of species might be distinguished: A "European" group with the type species *H. melanopsis* (HARDY, 1850) and *H. alpina* WAGNER, 1955, *H. tenuis* (GERMAR, 1821) and *H. signifer* (THEN, 1897), a ponto-turanic group formed by *H. anatolica* ZAKHVATKIN, 1946, *H. iranicola* ZAKHVATKIN, 1946, *H. ribauti* LINNAVUORI, 1953, *H. sevanensis* ZAKHVATKIN, 1946 and *H. turanica* ZAKHVATKIN, 1946, and a northern-holarctic group consisting of *H. youngi* BEIRNE 1954 and *H. dentata* (OSBORN & BALL, 1898). (see ANUFRIEV & EMELJANOV 1988, BEIRNE 1956, DELLA GIUSTINA 1989, HAMILTON 1997, DMITRIEV 2017, RIBAUT 1952, ZAKHVATKIN 1946).

About 20 years ago, Reinhard Remane realised, that another species of *Hardya* exists in Central Europe: It closely resembles *Hardya tenuis* in general appearance, but differs distinctly in details of its genitalia. This new species will be described here.

Material, abbreviations

The material studied is stored in the collections of Herbert Nickel, Göttingen, Germany (CHN) and in the collection of the Ökoteam-Institut für Tierökologie und Naturraumplanung, Werner Holzinger, Graz, Austria (OEKO).

***Hardya helgae* nov.sp.**

Material examined: Holotypus: male, Germany, Baden-Württemberg, Hohenstein-Oberstetten, Naturschutzgebiet Warmberg, Halbtrockenrasen, 48°18‘46‘‘N, 9°20‘01‘E, 780 m a.s.l., 07.08.1997, H. Nickel leg. (OEKO). – Paratypes: same locality and date as holotype 16♂♂, 11♀♀, 1 nymph (CHN & OEKO); Oberbergen (Kaiserstuhl, 48°05'23"N 7°39'38"E), 18.08.1998, 3♂♂, 5♀♀, 1 nymph; Mahlstetten, Kraftstein (48°02'19"N 8°50'13"E), 850 m, 20.08.1998, 1♂, 2♀♀, 1 nymph; Stuttgart, Riedenberg, NSG Eichenhain, (48°44'8"N 9°12'31"E) 24.06.1993, 3♂♂, 2♀♀ (SMNS, F. Heller leg.); Jungingen, NSG Bürgle (48°19'32"N 9° 3'28"E), 3♂♂, 6♀♀, all CHN. – Additional localities (all Germany; see also Fig. 6): Altvogtsburg Badberg (48° 5'- 6'N 7°40'-41'E), Altvogtsburg Haselschacher Buck (48° 5'57"N 7°41'39"E), Bad Münstereifel Kuttenberg (50°34'32"N 6°43'39"E), Bad Münstereifel Wachendorfer Berg (50°34'36"N 6°44'12"E), Balingen Schafsberg (48°13'0"N 8°48'50"E), Bissingen an der Teck Eichhalde (48°34'52"N 9°29'33"E), Bopfingen Ipf (48°52'7"N 10°21'30"E), Böttingen Alter Berg (48° 5'34"N 8°48'16"E), Buttenhausen Eichhalde (48°22'7"N 9°27'58"E), Efringen-Kirchen Blansinger Grien-West (47°40'12"N 7°31'22"E), Eglingen Krähberg (48°20'43"N 9°25'32"E), Ensingen Eselsburg (48°58'27"N 8°57'30"E), Geddelsbach (49° 8'32"N 9°30'19"E), Geisingen (47°55'41"N 8°41'14"E), Gomadingen Sternberg (48°23'30"N 9°22'35"E), Grißheim Trockenaue Nord (47°52'41"N 7°33'49"E), Grißheim Trockenaue Süd (47°52'18"N 7°33'55"E), Gültlingen Killberg (48°39'1"N 8°47'8"E), Hechingen Beurener Heide (48°21'50"N 9° 2'37"E), Inzlingen Butterbergshalde (47°35'26"N 7°41'33"E), Istein Totengrien (47°39'15"N 7°32'10"E), Kallmünz Eicherberg (49°10'27"N 11°58'14"E), Kallmünz Schlossberg (49° 9'43"N 11°57'4"E), Killer NSG Nähberg (48°18'31"N 9° 4'55"E), Landshut Standortübungsplatz (48°33'47"N 12°13'29"E), Machtolsheim NSG Heiden im Langen Tal (48°28'52"N 9°45'1"E), Oberbergen Bassgeige (48° 6'28"N 7°39'9"E), Oberstetten Halmberg (48°19'23"N 9°18'35"E), Oberstetten NSG Steinberg (48°19'12"N 9°18'56"E), Rheinweiler Kapellengrien (47°42'9"N 7°31'12"E), Schelingen Ohrberg (48° 6'15"N 7°41'33"E), Schelingen Bluttenbuck (48° 6'29"N 7°41'19"E), Schelingen Schelinger Höhe (48° 6'15"N 7°41'30"E), Schützingen Spiegel (49° 0'10"N 8°54'4"E), Talheim Wacholderheide am Farrenberg (48°22'52"N 9° 4'32"E), Westgartshausen (49° 7'42"N 10° 6'56"E).

Etymology

The species is named in honour of the third author’s wife Helga Remane. She gave him (RR) life-long support and was always a very kind host for us (HN, WH) during our visits in Marburg.

Description

A typical *Hardya* species concerning body shape and colouration. Body size of males 2.7-3.2 mm, females slightly larger (3.0-3.4 mm). Body shape moderately elongate, head produced, apically rounded. Head shorter and wider than pronotum. Forebody yellowish-brown, shining. Vertex along fore margin with six small black spots and a dark line with four strong windings (Figs 1 A-D). In strongly pigmented specimens the lateral winding may form a large dark spot.

Face with variable dark brown markings: Frontoclypeus with dark transverse lines con-

nected with each other by a longitudinal median bar. Lorae broadly bordered dark, anteclypeus with a dark median stripe. Anterior part of pronotum with irregular ochre and brown markings. Scutellum with orange lateral angles. Fore wings translucent with light browish tinge, in more strongly pigmented specimens more or less uniformly dirty brownish with dark markings usually confined to apical margin.

Thorax and abdomen mostly black. Legs mostly yellowish-brown with dark markings.

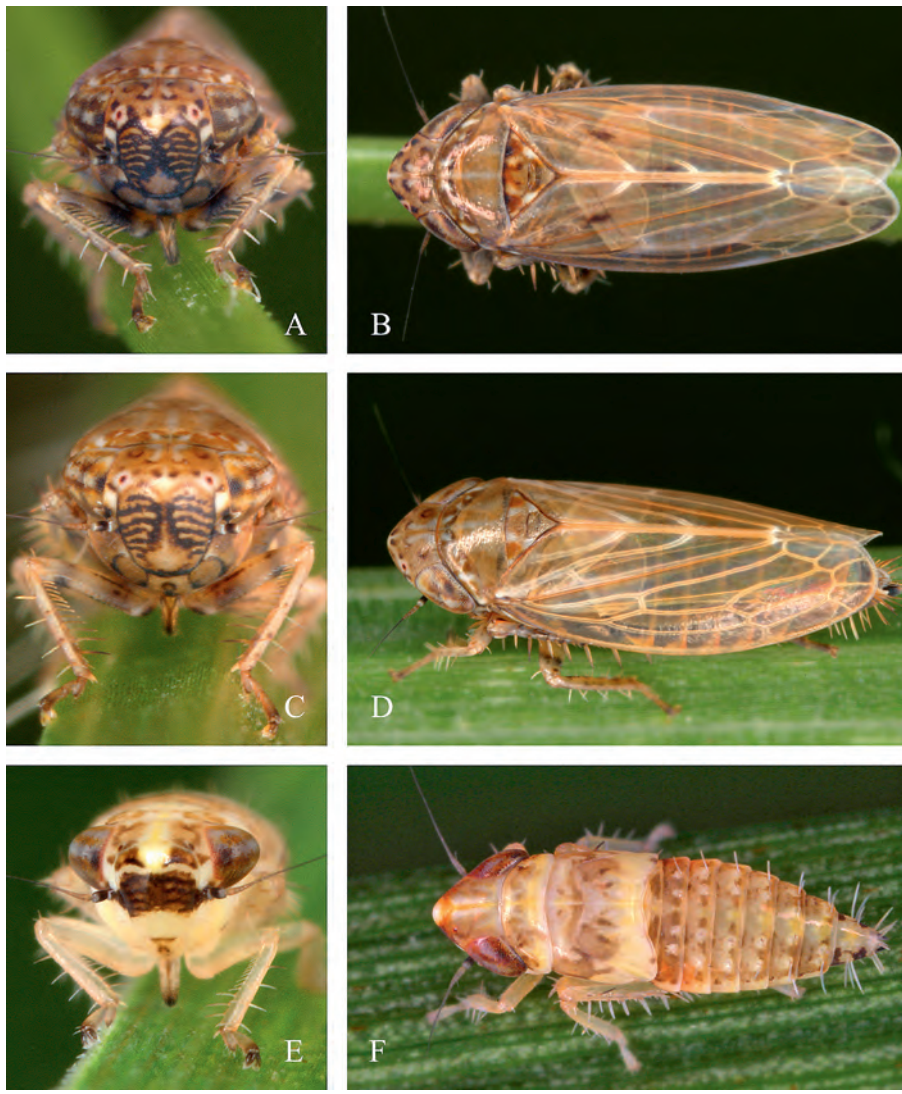

Fig. 1: *Hardya helgae* nov.sp., face and habitus photos. **A** and **B** male, **C** and **D** female, **E** and **F** nymph. Photos G. Kunz.

Differential diagnosis

Diagnostic characters mostly refer to the morphology of the male genitalia. *Hardya helgae* nov.sp. can be identified by the combination of the following characters: Genital plates are divided into uneven (not even) halves, the posterior being distinctly narrower than the anterior. The inner lobe of the genital styles is rounded (not angular or bulged), the comb-like process of the pygofer bears a long (not short) ventral spine. Furthermore the new species is much smaller than the similar *H. tenuis* without any overlap, and females are subbrachypterous in *H. helgae* but always macropterous in *H. tenuis*.

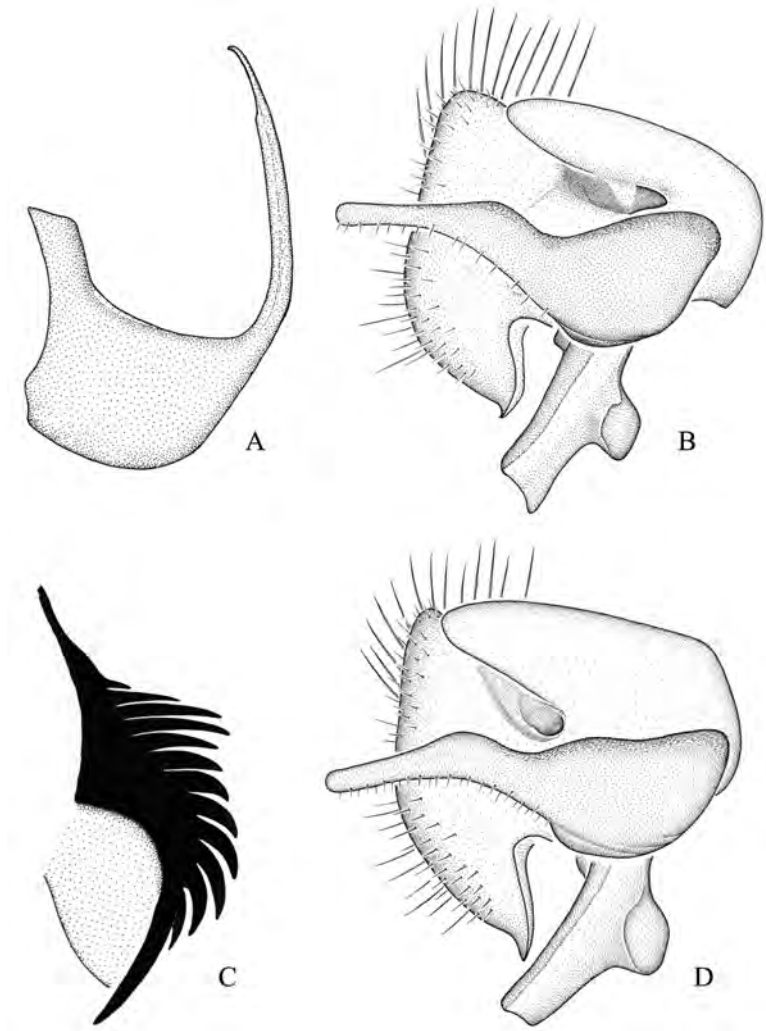

Fig. 2 A - C: *Hardya helgae* nov.sp., male genitalia: **A** = aedeagus, lateral view, **B** = genital style & plate (inner maximum view), **C** = apex of pygofer lobe, lateral view. – D: *Hardya tenuis*, genital style & plate (inner maximum view). Ch. Bückle fec.

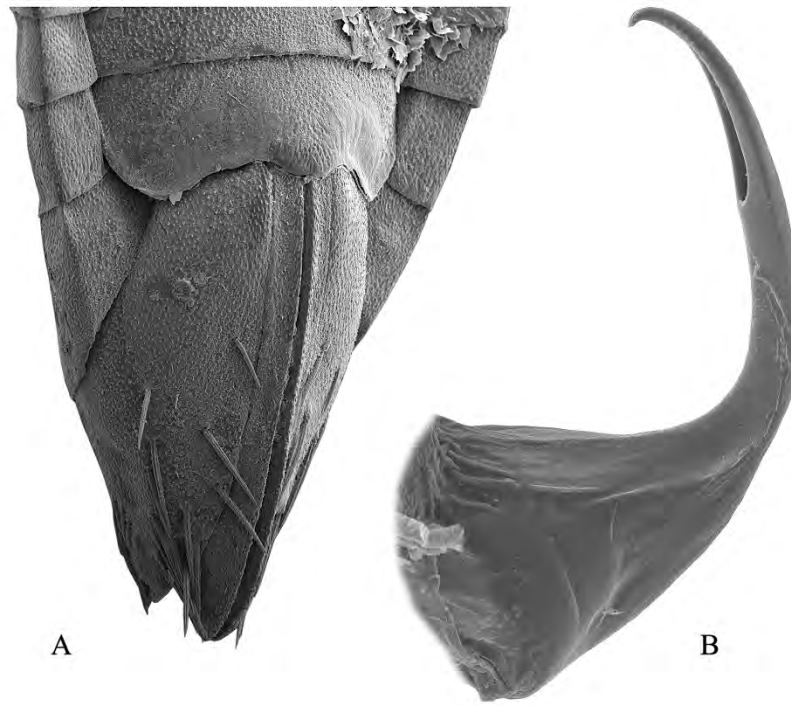

Fig 3: *Hardya helgae* nov.sp., SEM photos of **A** = tip of the female abdomen, **B** = aedeagus (lateral view). H.P.-Bojar & W.E. Holzinger fec.

Key to the *Hardya* species of central Europe
(see also Tab. 1)

1 Large species, body size of males more than 3.4 mm, of females more than 3.5 mm. Females macropterous, i.e. fore wings overlap the tip of the abdomen by far. Last tooth of the comb-like apex of the pygofer in males very long ..... *Hardya tenuis*

* Smaller species, body size of males smaller than 3.2 mm, of females smaller than 3.5 mm. Females macropterous or subbrachypterous (i.e. fore wings end and the tip of the abdomen).....2

2 Male genital styles with a ±rectangular basal part, its distal border forming a bulge or right angle (Fig. 5 A)..... *Hardya signifer*

* Male genital styles with a ±triangular base, its distal border ±straight or S-shaped (Fig. 5 B-E).....3

3 Distal border of male genital styles almost straight. Females always macropterous .... *Hardya alpina*

* Distal border of male genital styles distinctively s-shaped. Females always subbrachypterous.....4

4 The cone emerging from the genital plate overlaps the genital style in its middle ....*Hardya melanopsis*

* The cone emerging from the genital plate overlaps the genital style close to its inner apex..... *Hardya helgae*

Tab. 1: Diagnostic characters for the identification of *Hardya* species in Europe.

Character	*H. helgae*	*H. tenuis*	*H. melanopsis*	*H. signifer*	*H. alpina*
Genital plate	Divided by a deep split, posterior part distinctly narrower than anterior part	Divided by a deep split, posterior and anterior part of equal size	As in *H. helgae*	As in *H. tenuis*	As in *H. tenuis*
Genital styles	Distal margin s-shaped, inner lobe broadly rounded	As in *H. helgae*, but inner lobe more angular	As in *H. helgae*, but outer lobe shorter and thicker, apically twisted and truncate	Distal margin with a triangular to bulgy projection, outer lobe short and thick, curved cephalad	Distal margin almost straight, inner lobe angular, outer lobe long and straight
Pygofer comb	With long ventral spine	With very long ventral spine	Ventral spine only slightly elongated	As in *H. melanopsis*	As in *H. melanopsis*
Aedeagus in lateral view	With almost parallel-sided socle and straight tip	Apical part more or less straight	Curved, with hook-like apex	Stem evenly and moderately curved throughout	Stem evenly and moderately curved throughout
Fore wing colouration	Dark markings usually absent or indistinct except on wing tip	2 distinct rows of dark spots in clavus and along middle of wing; dark wedge on wing tip	Usually strongly pigmented, most cells brown, bordered with black	Pigmentation usually weak, sometimes with 2 rows of spots, but without apical wedge	Pigmentation weak, few dark spots in the basal half, wing tip with distinct dark markings
Body length	♂: 2.8-3.1 mm ♀: 3.0-3.4 mm	♂: 3.5-3.8 mm; ♀: 3.6-4.0 mm	♂: 2.8-3.1 mm; ♀: 3.0-3.2 mm	♂: 2.5-3.0 mm; ♀: 2.9-3.2 mm	♂: 2.5-2.7 mm; ♀: 2.7-2.8 mm

Taxonomic notes

Two old names had to be checked concerning conspecificity with the new species:

Thamnotettix tenuis confusa REY, 1894 was listed by METCALF (1967, p. 261) as younger synonym ("n. var.") of *H. tenuis*. The name refers to two specimens from Lyon and Collioure (France). The original description is only three lines short, refers only to external characters and does not allow any species-specific classification (REY 1894). On request to Harold Labrique and Joël Clary (Musée des Confluences, Lyon) about Rey's collection we were sent the following information: "*Thamnotettix tenuis* var. *confusa* REY: 1 male destroyed(!) plus 1 female in good condition (box 4611904). Remark: this form is really different from *Jassus confusus* REY with 3 specimens in good condition in the same box." Photographs of both specimens showed that the specimen card with the male held only the left hind leg, the right fore and the middle leg. Thus the identity of the name-bearing specimens is unclear, *Th. tenuis confusa* REY has to be treated as nomen dubium.

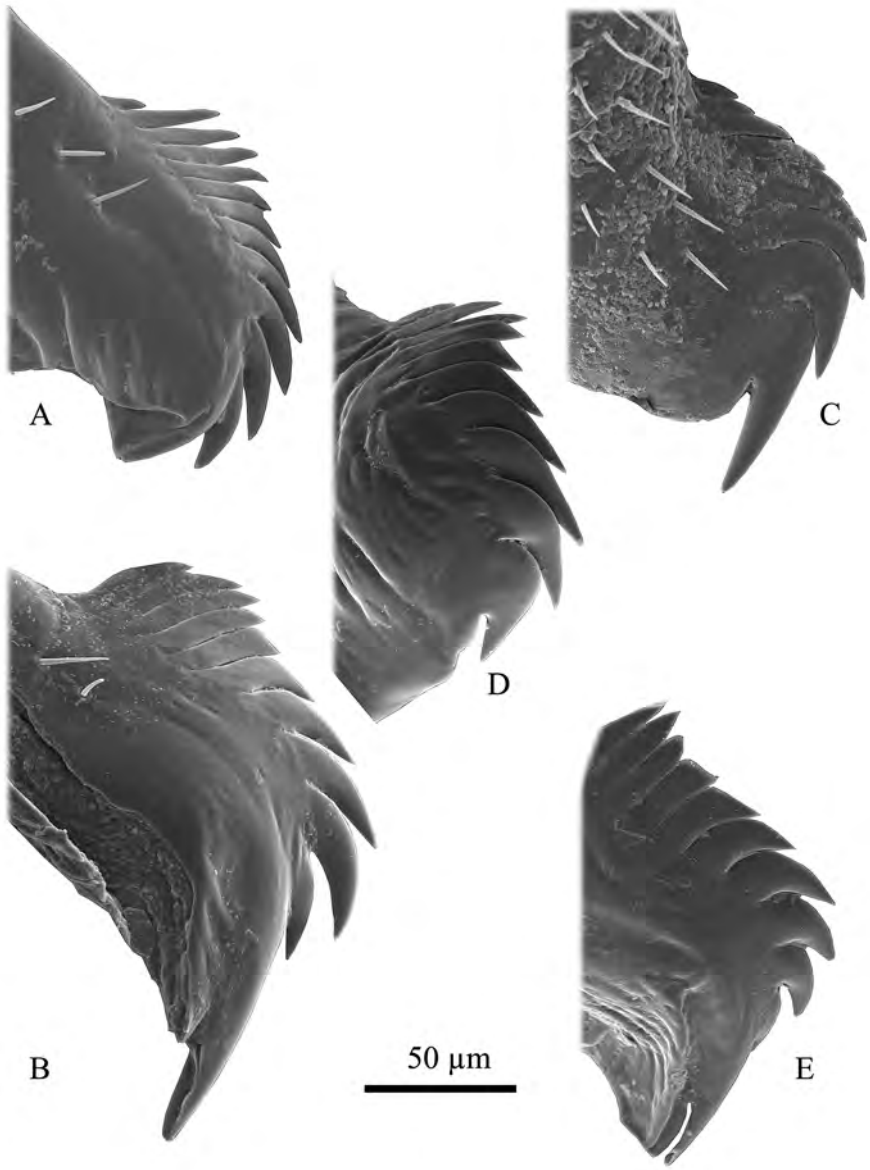

Fig 4 A-E: Comb-like apex of pygofer lobes of european *Hardya* species: **A** = *H. signifer*, **B** = *H. tenuis*, **C** = *H. alpina*, **D** = *H. melanopsis*, **E** = *H. helgae*. Scale bar = 50 µm. H.P.-Bojar & W.E. Holzinger fec.

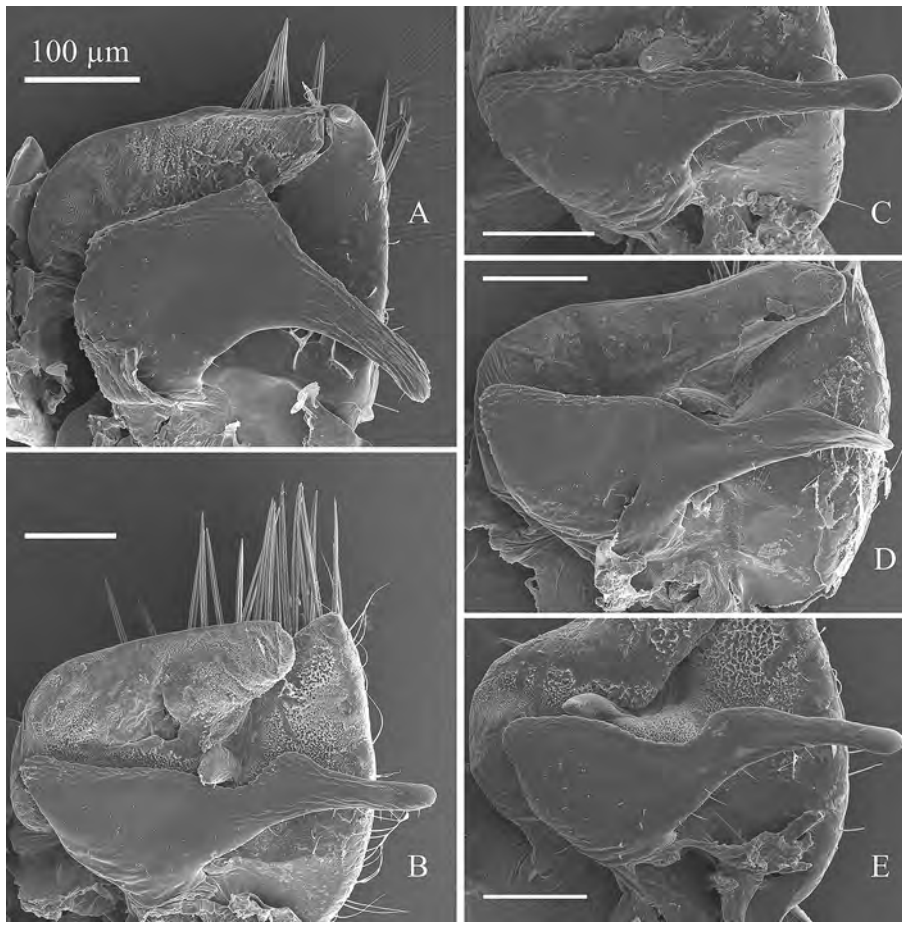

Fig 5 A-E: Genital styles of european *Hardya* species: **A** = *H. signifer*, **B** = *H. tenuis*, **C** = *H. alpina*, **D** = *H. melanopsis*, **E** = *H. helgae.* Scale bar = 100 µm. H.P.-Bojar & W.E. Holzinger fec. Remarks: The triangular tip in *H. signifer* might often be larger (even bulged) than in the figured specimen. The tip of the finger-like process in *H. melanopsis* is blunt like in *H. alpina*, but not visible because of the perspective.

Thamnotettix aphrodoides HAUPT, 1935, described after a single female from Bonn (Germany), has erroneously been treated as a member of the genus *Hardya* and a younger synonym of *H. melanopsis* by METCALF (1967: 258) and subsequent workers. The type specimen is not present in Haupt's collection (now SNSD, Dresden) and his description does not at all correspond to any *Hardya* species, but much more to *Sardius argus* (MARSHALL, 1866) which is also known to occur in the vicinity of Bonn (but not *H. melanopsis*). Therefore *Thamnotettix aphrodoides* HAUPT, 1935 is most probably a younger synonym of *Sardius argus*.

Distribution, habitat, biology

The localities of *Hardya helgae* are shown in Fig. 6. Its known range extends from southern parts of North Rhine-Westphalia (Eschweiler and Iversheim near Bonn) and Luxembourg (near Heisdorf) in the north to Lörrach (Baden-Württemberg) near Basel in the south, and from Colmar (Alsace, France) in the west to Kallmünz (Bavaria) in the east.

The first records of this species were published by ROMBACH (1999) sub "*Hardya* spec. aff. *tenuis*" from the Nordeifel region (Wachendorfer Berg, Kuttenberg bei Bad Münstereifel-Eschweiler) and from France ("Burgundische Pforte und südlich von Colmar [Remane, mdl. Mitt.]")

The species is locally common or even abundant on moderately dry, mostly calcareous grassland grazed by sheep or cattle or also mown ("Halbtrockenrasen" or "Mesobrometum") in large parts of southwestern Germany, and particularly common in the Schwäbische Alb (Swabian Jura) and the Kaiserstuhl region, with scattered records in the Fränkische Alb (Franconian Jura), the Eifel (ROMBACH 1999) and the southern half of Luxembourg (listed as "*Hardya* cf. *tenuis*" in NIEDRINGHAUS et al. 2010). The host plant is always *Bromus erectus*. In some places it may occur syntopically with *H. tenuis*, but at a small scale both species are usually found in separate patches due to their different host plants, the latter species reproducing on *Festuca ovina*, but migrating to other plants (including coniferous trees) in the cold season.

There is little doubt that the new species has been expanding its range at least during the last three decades. The same is known from its host plant *Bromus erectus* and the planthopper *Ditropsis flavipes* (SIGNORET, 1865) which is the second central European host plant specialist of that grass. R. Remane (unpublished data), who did exhaustive collecting in the Kaiserstuhl area and in other parts of southwestern Germany between 1949 and 1980, never collected *Hardya helgae*, in these decades. In addition, the collections of Friedrich Heller (Museum für Naturkunde Stuttgart, SMNS) cover large parts of Baden-Württemberg and were gathered mainly from the 1970s until the 1990s. They only hold a single record dating from 1993 near Stuttgart. Since the species is easily collected with the sweepnet it seems quite unlikely that it was overlooked by these two experienced hemipterologists. In fact the earliest record from Germany (Kaiserstuhl) dates from 1986 (leg. C. Gack).

Due to land use changes in grazing regimes and increased mowing the host plant *Bromus erectus* has extended its range in large parts of Germany only recently (LANGE 1998, HEINRICH 2010); even in Baden-Württemberg the earliest confirmed reports are not from before 1740 AD (KÖRBER-GROHNE 1990, SEBALD et al. 1998). Therefore it fulfills the criteria for being classified as a neophyte in the same way as POSCHLOD (2015) did for the common meadowgrass *Arrhenatherum elatius*. Using the same definitions, *Hardya helgae* might even be classified as a neozoon for Central Europe that has immigrated with its host plant.

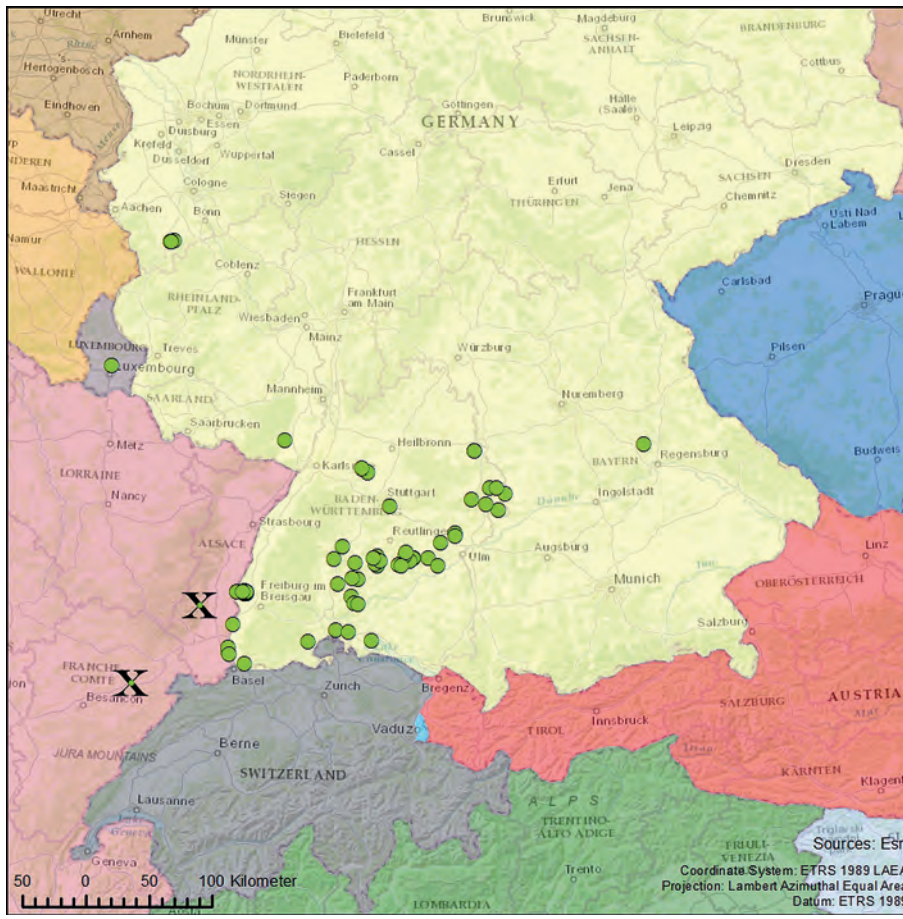

Fig 6: Distribution of Hardya helgae in Southern Germany, Luxembourg and Eastern France (Alsace) based on known localities. Green circles = our records; black X = Remane coll. fide ROMBACH (1999).

Hardya helgae is quite likely a bivoltine species hibernating in the adult stage. Adults of the previous year can be found until early June. ROMBACH (1999) confirms overwintering adults with catches in October, February and March. However, it remains uncertain if there are two or (in warmer parts of its range) three annual generations. Fig. 6 shows all available data from Baden-Württemberg. Sampling was not conducted systematically, and localities cover an altitudinal range from 200 m to 1.000 m making an interpretation difficult. The early peak in June refers mostly, but not exclusively to data gathered from the very warm Kaiserstuhl region. The two peaks in July and August/September suggest two generations, the second one would hibernate.

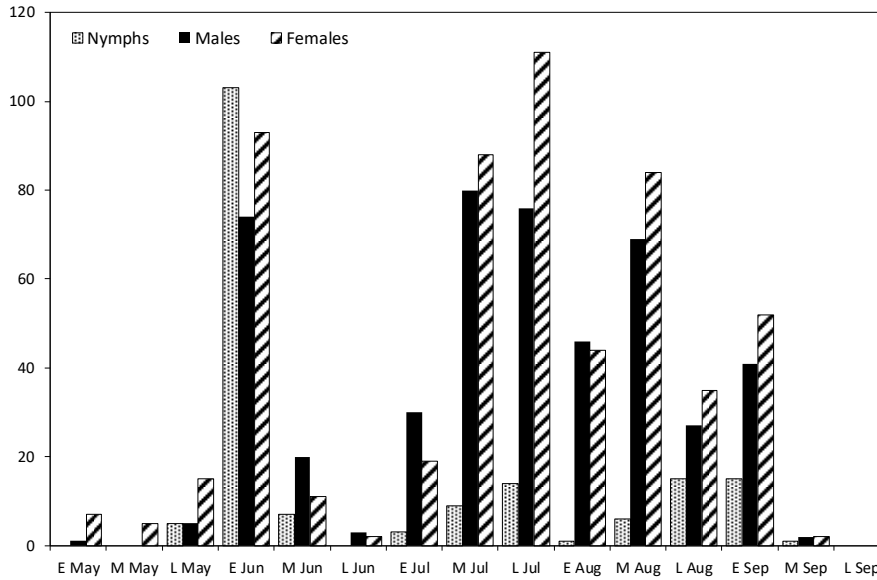

Fig. 7: Seasonal distribution of *Hardya helgae* nov.sp. recorded in Baden-Württemberg. E = early, M = mid, L = late. For details see text.

Acknowledgements

We thank Harold Labrique and Joël Clary (Musée des Confluences, Lyon) for their help concerning the type of *Thamnotettix tenuis* var *confusa* REY and Dr. Wolfgang Schawaller (Staatliches Museum für Naturkunde Stuttgart) for allowing access to the Friedrich Heller collection. We are grateful to Dr. Hans-Peter Bojar (Universalmuseum Joanneum, Graz, A) for the SEM photos, Dr. Christoph Bückle, Tübingen (D), for the drawings and for the loan of *Hardya alpina*, Mag. Gernot Kunz, Graz (A), for the habitus photos and Mag. Philipp Zimmermann, Graz (A) for GIS support.

Zusammenfassung

Hardya helgae nov.sp., eine neue Zwergzikadenart aus Mitteleuropa. – Eine neue Zikadenart aus der Gattung *Hardya* EDWARDS, 1922 wird aus Südwest-Deutschland, Ostfrankreich und Luxemburg beschrieben. Sie ist der weitverbreiteten Art *Hardya tenuis* (GERMAR, 1821) äußerlich sehr ähnlich, unterscheidet sich jedoch deutlich von dieser im Bau der Genitalklappen, in Körpergröße und Flügellänge der Weibchen. Es gibt auch Unterschiede in der Habitatpräferenz: die neue Art ist auf mehr oder weniger trockene Kalkmagerrasen beschränkt und lebt an *Bromus erectus*, während *H. tenuis* auch auf sauren Substraten vorkommt und an *Festuca ovina* lebt. Es ist davon auszugehen, dass die Art, ihrer Wirtspflanzen folgend, sich erst in den vergangenen Jahrzehnten in Mitteleuropa etabliert hat.

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